Aluminum Lithium Alloy 2195 Fusion Welding Improvements with New Filler Wire

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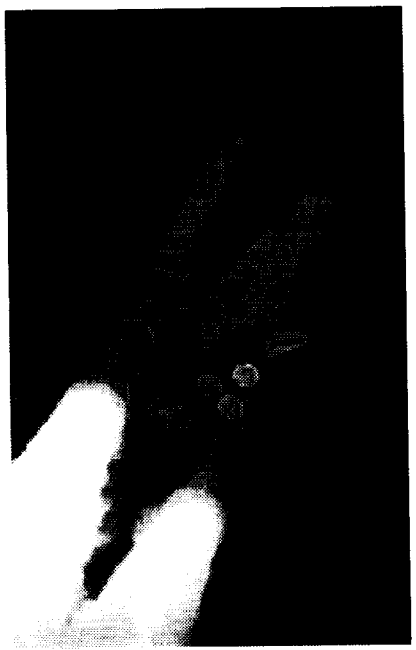
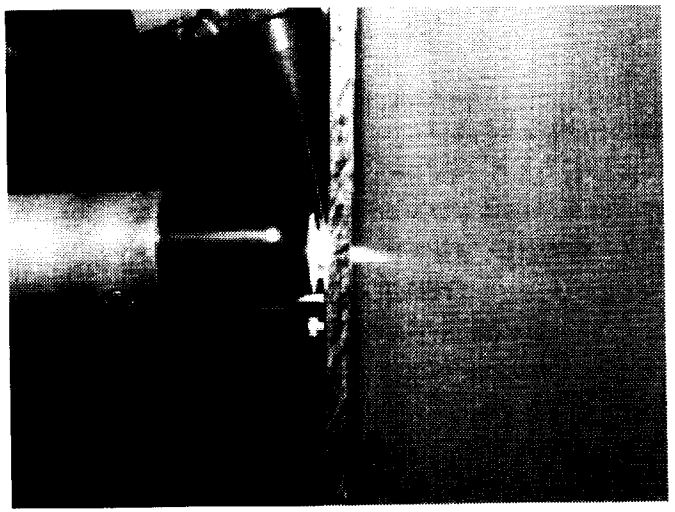
2195 Fusion Welding Improvements with New Filler Wire

Background

- **Welding 2195 Aluminum Lithium for the Space Shuttle Super Lightweight External Tank**



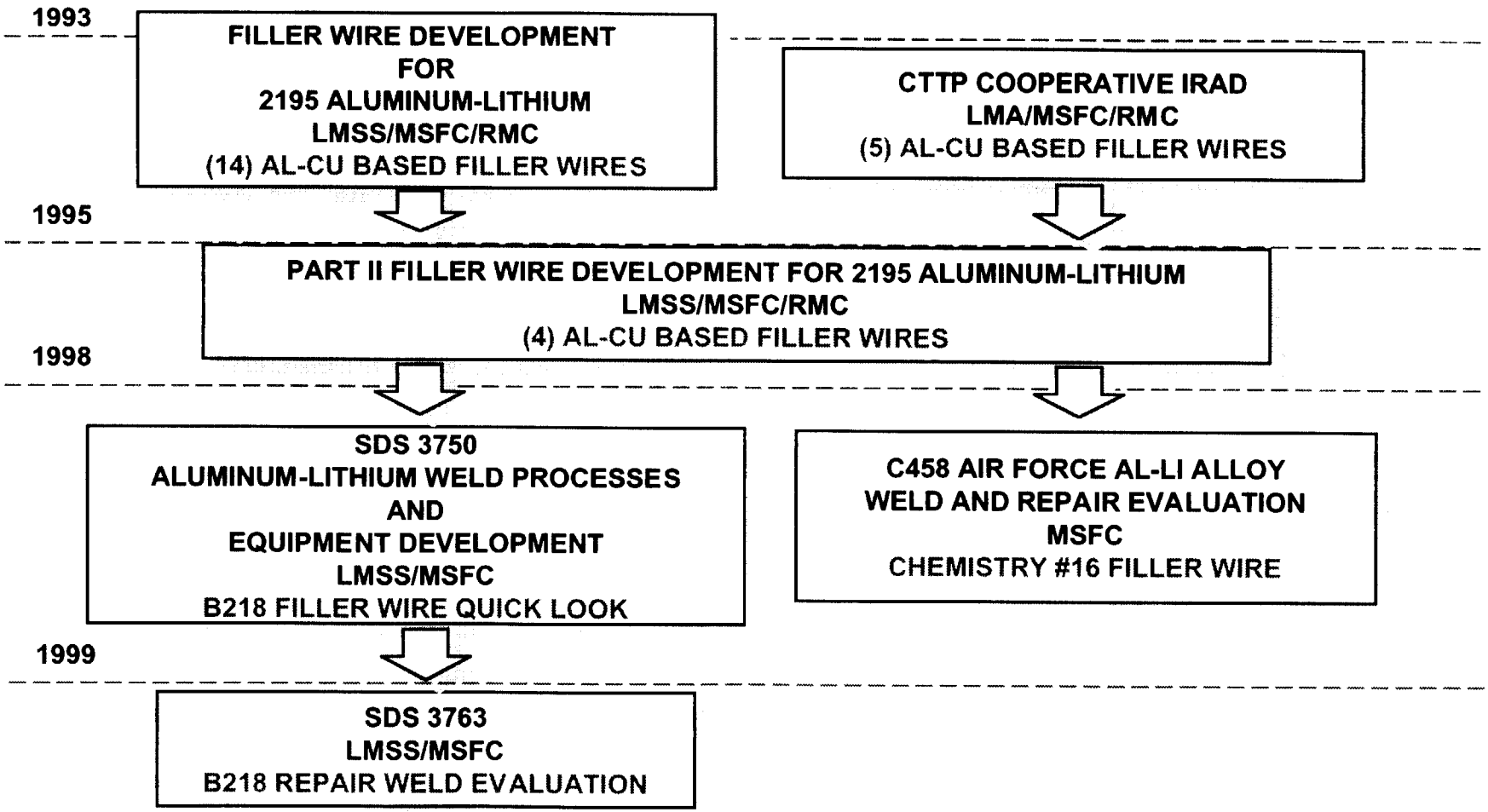
NASA Space Shuttle



Variable Polarity Plasma Arc Welding

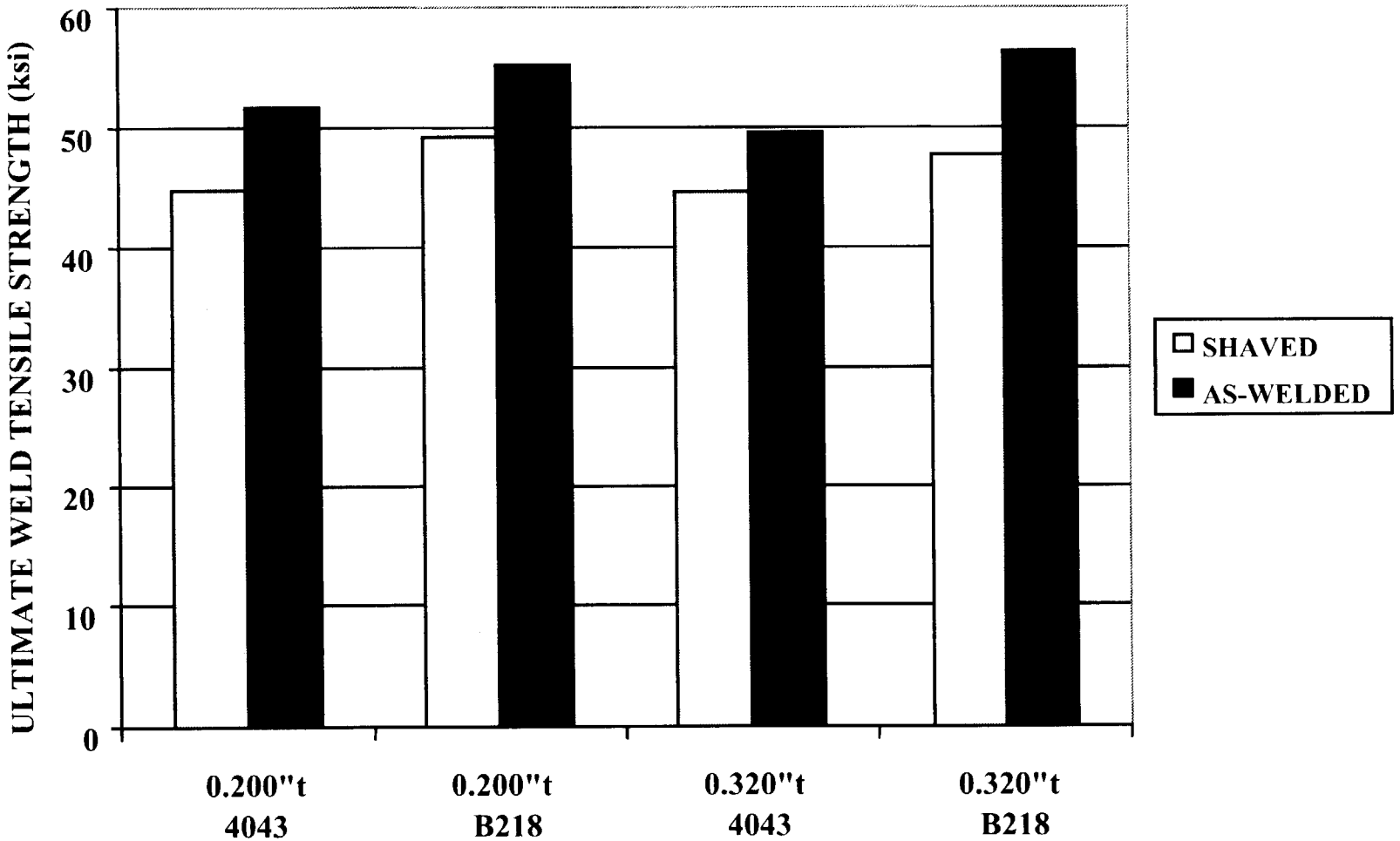
2195 Fusion Welding Improvements with New Filler Wire

Background



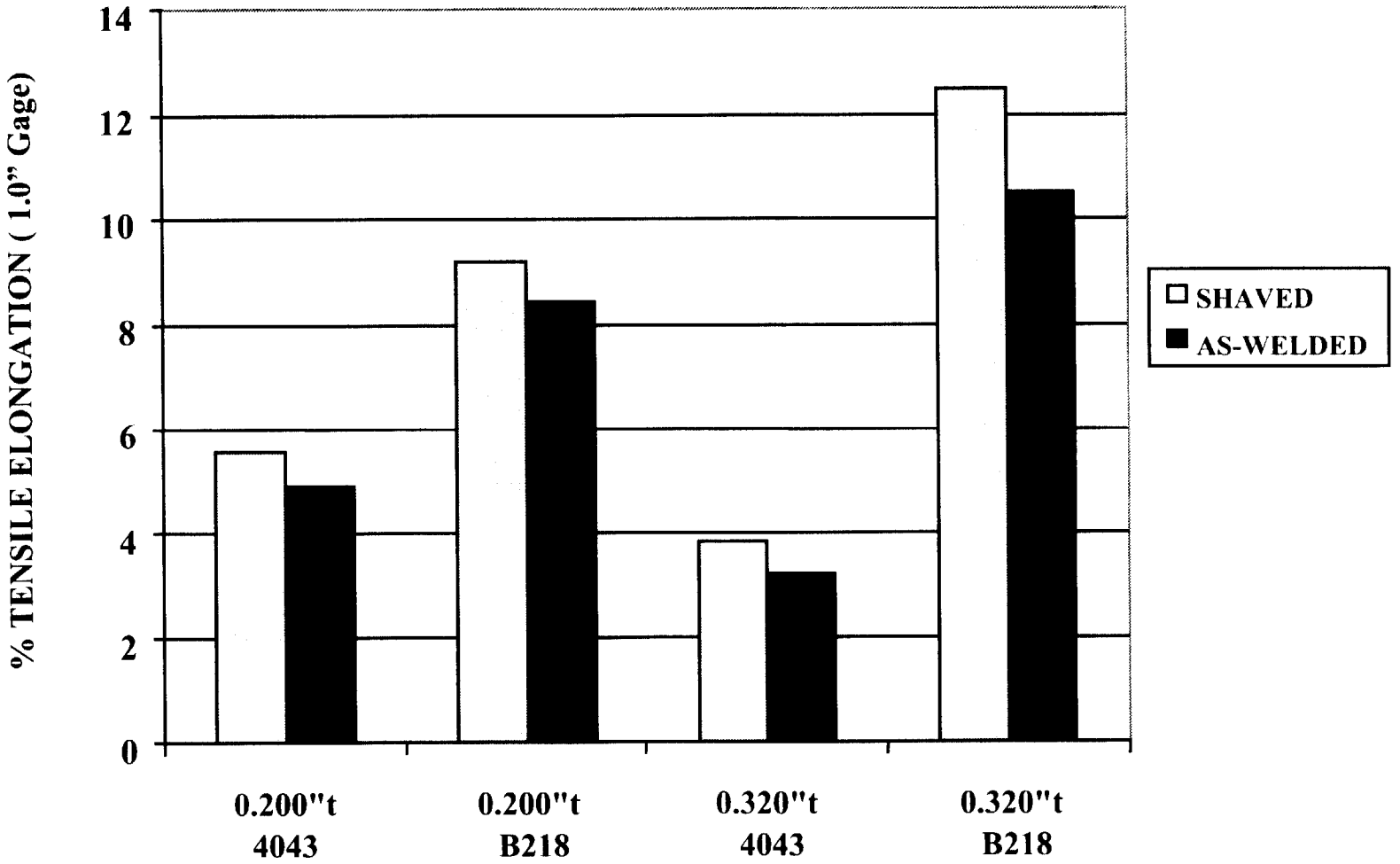
2195 Fusion Welding Improvements with New Filler Wire

2195T8M4 VPPA Weld Ultimate Tensile Strength



2195 Fusion Welding Improvements with New Filler Wire

2195T8M4 VPPA Weld Tensile Elongation

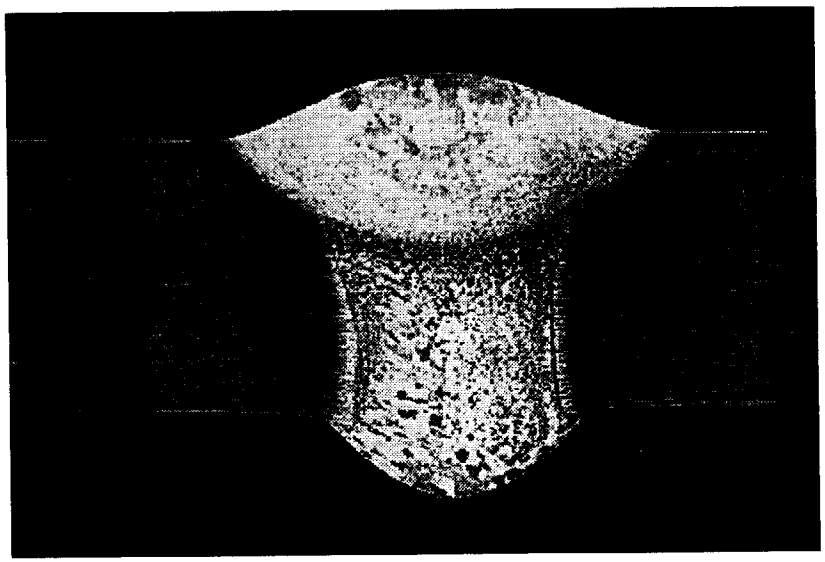


2195 Fusion Welding Improvements with New Filler Wire

VPPA Weld Grain Structure Comparison

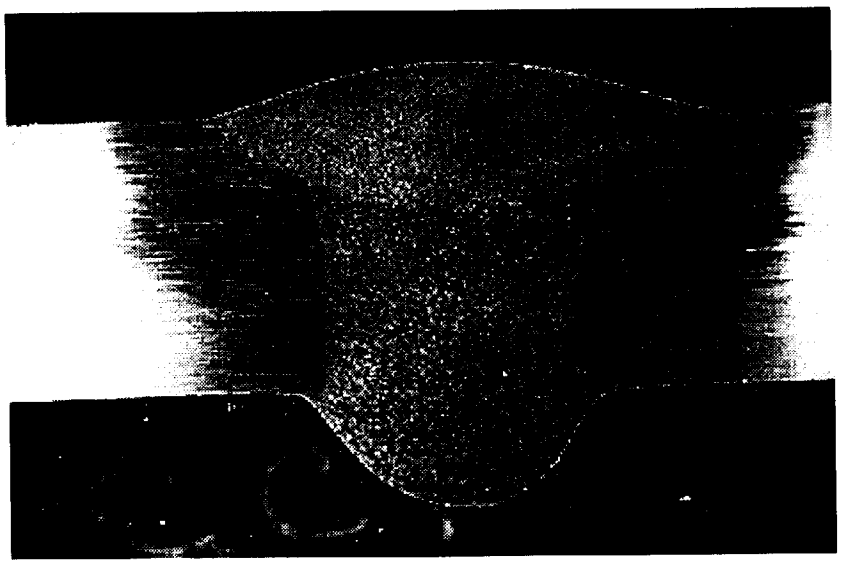
0.320t 2195 PLATE TO 2195 PLATE VPPAW

4043 WELD FILLER WIRE



10X Original Magnification

B218 WELD FILLER WIRE

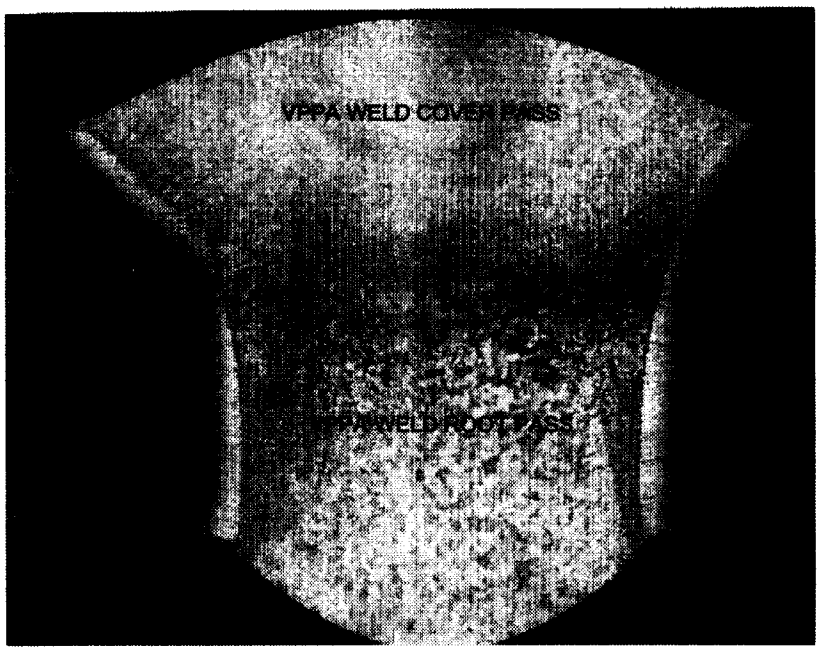


10X Original Magnification

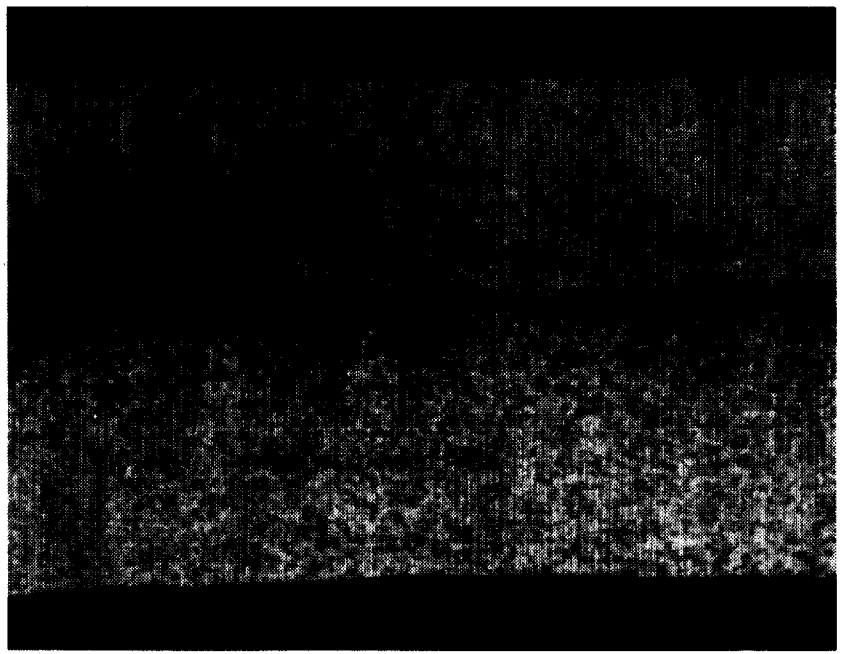
2195 Fusion Welding Improvements with New Filler Wire

B218 VPPA Weld Grain Structure

0.200t 2195 PLATE TO 2195 PLATE VPPAW



10X Original Magnification

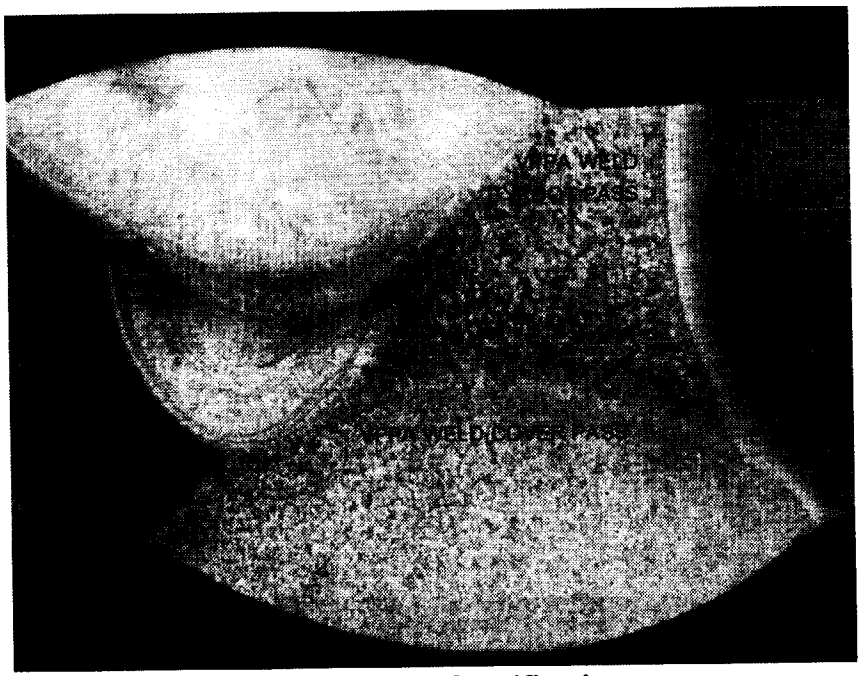


10X Original Magnification

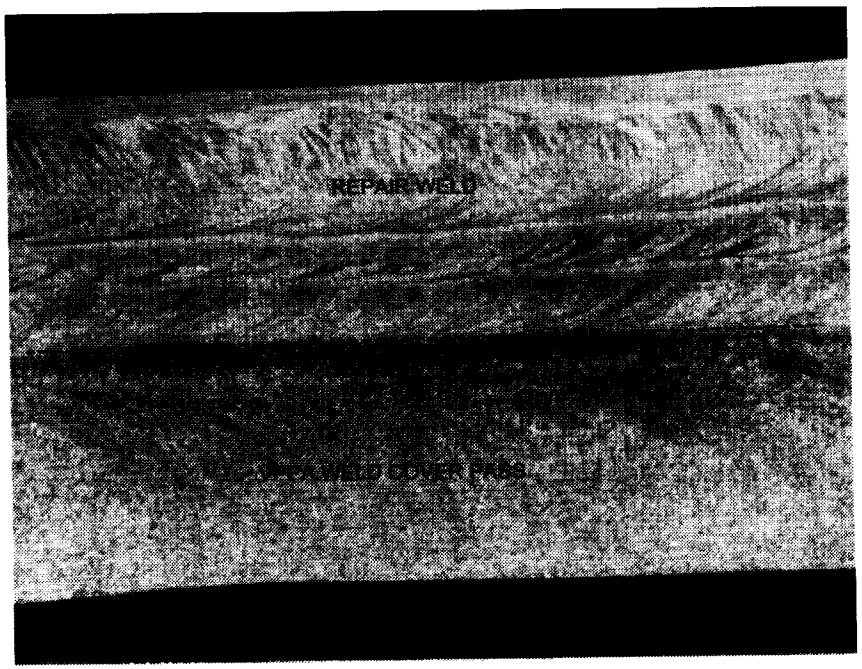
2195 Fusion Welding Improvements with New Filler Wire

B218 GTA Repair Weld Grain Structure

R1 GTA Repair 0.200t 2195 PLATE TO 2195 PLATE VPPAW



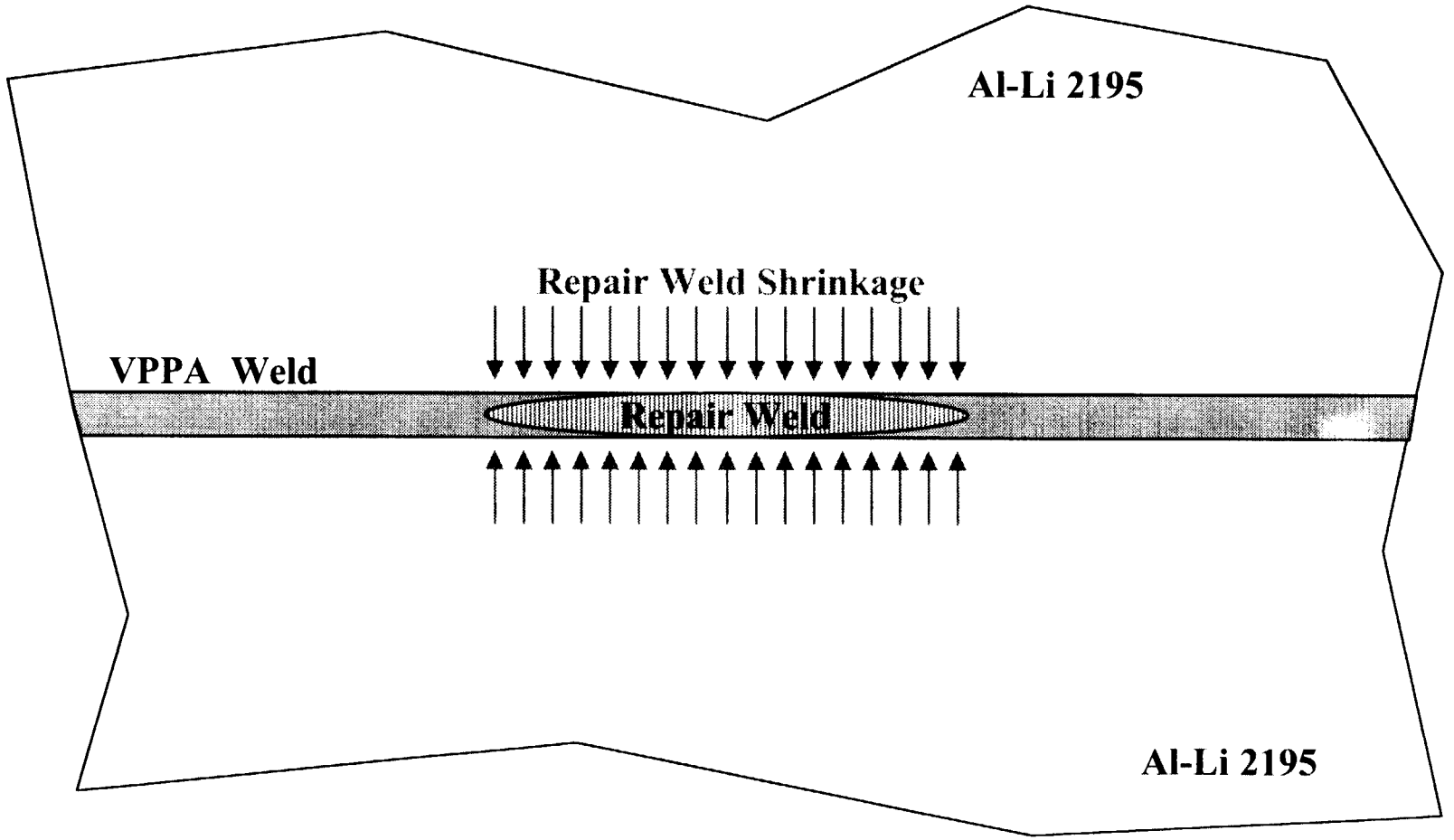
10X Original Magnification



10X Original Magnification

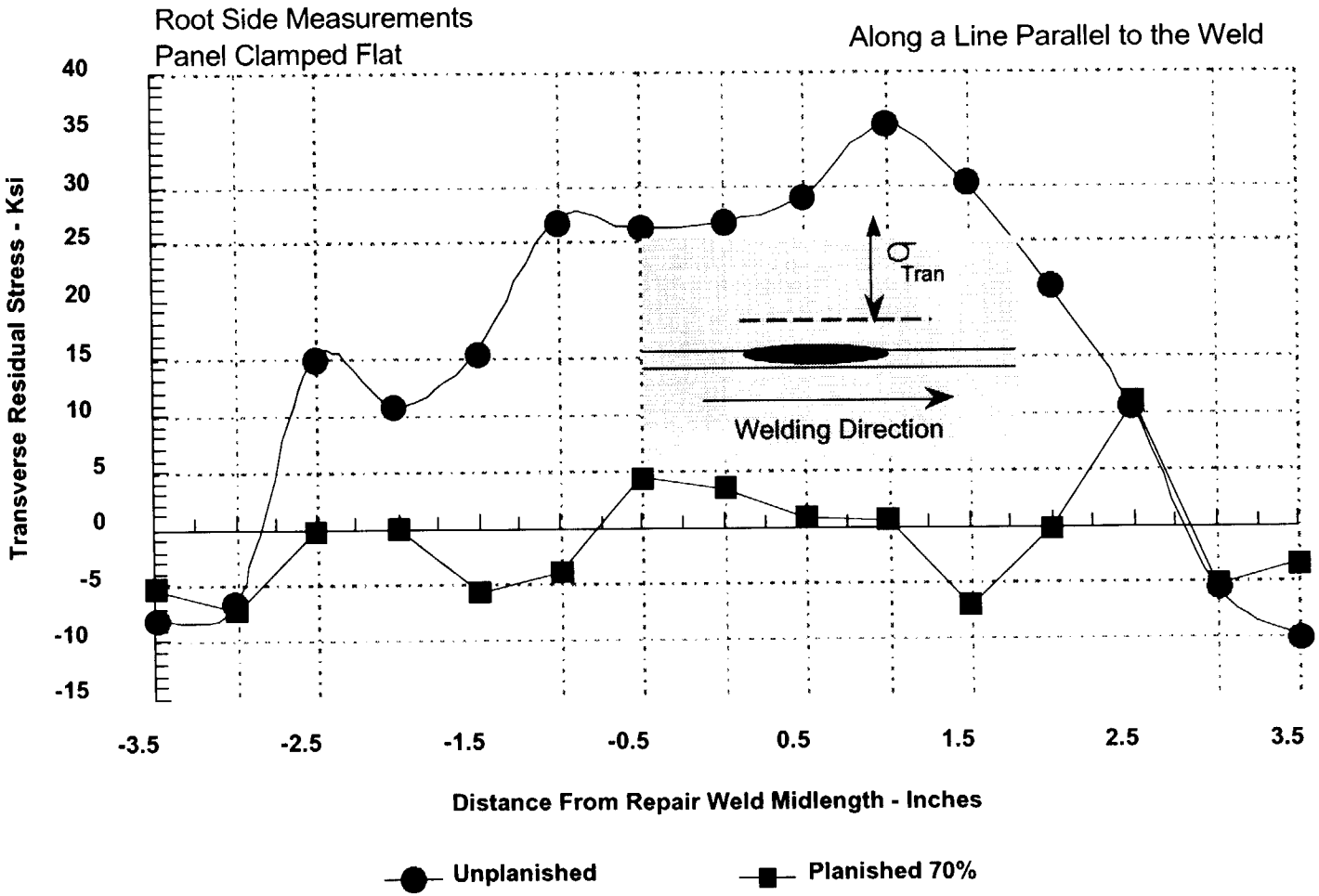
2195 Fusion Welding Improvements with New Filler Wire

2195 Repair Weld Residual Stresses



2195 Fusion Welding Improvements with New Filler Wire

2195 Repair Weld Residual Stresses

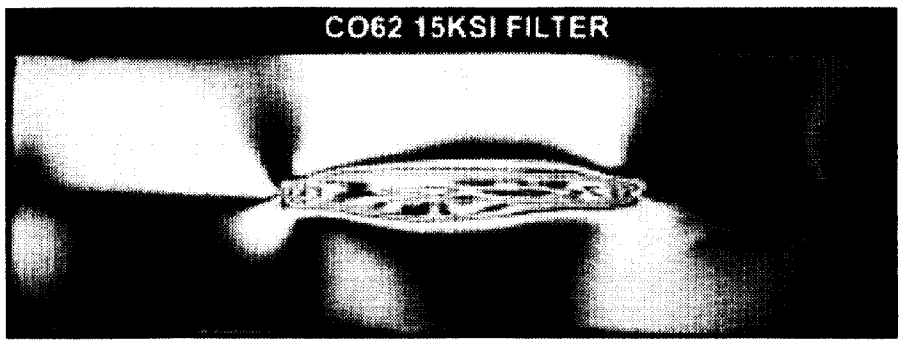


2195 Fusion Welding Improvements with New Filler Wire

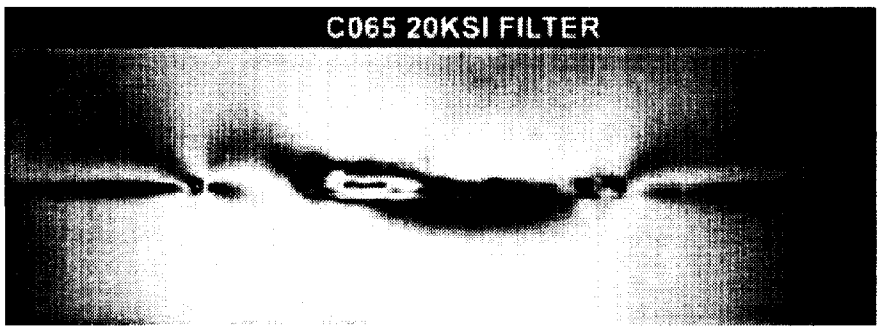
2195 Repair Weld Residual Stresses

R5 GTA Repair 0.200t 2195 PLATE TO 2195 PLATE VPPAW

Photostress of Unplanished Repair Weld



Photostress of Planished Repair Weld



2195 Fusion Welding Improvements with New Filler Wire

Objective

- Assess B218 weld filler wire for Super Lightweight External Tank production, which could improve current production welding and repair productivity.

Approach

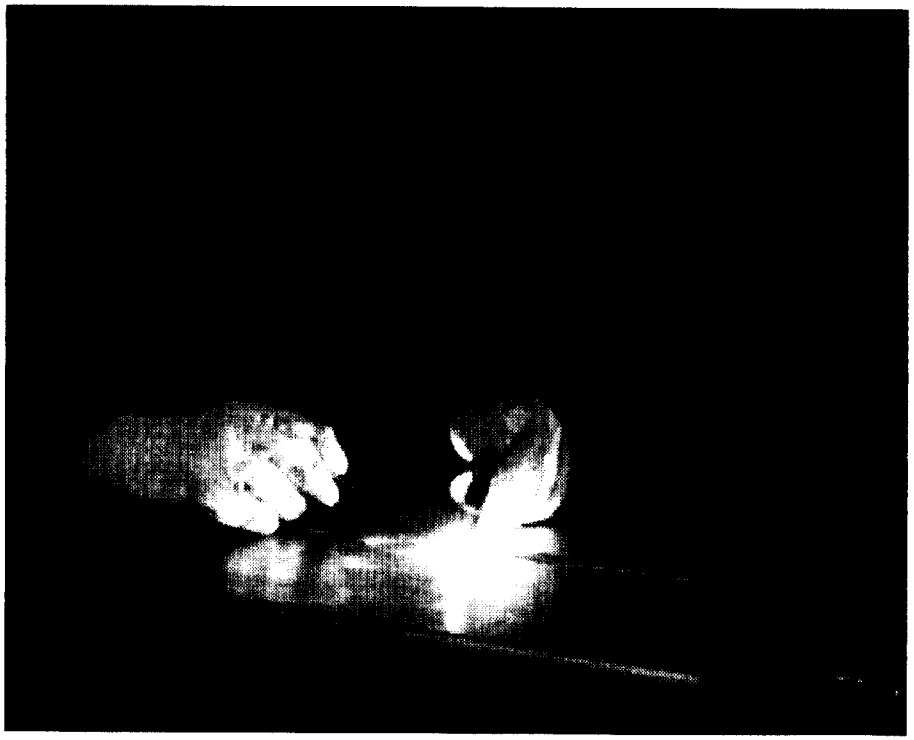
- Perform a repair weld quick look evaluation between 4043/B218 and B218/B218 weld filler wire combinations. Evaluate tensile properties for planished and unplanished conditions.

- Perform repair weld evaluation on structural simulation panel using 4043/B218 and B218/B218 weld filler wire combinations. Evaluate tensile and simulated service fracture properties for planished and unplanished conditions.

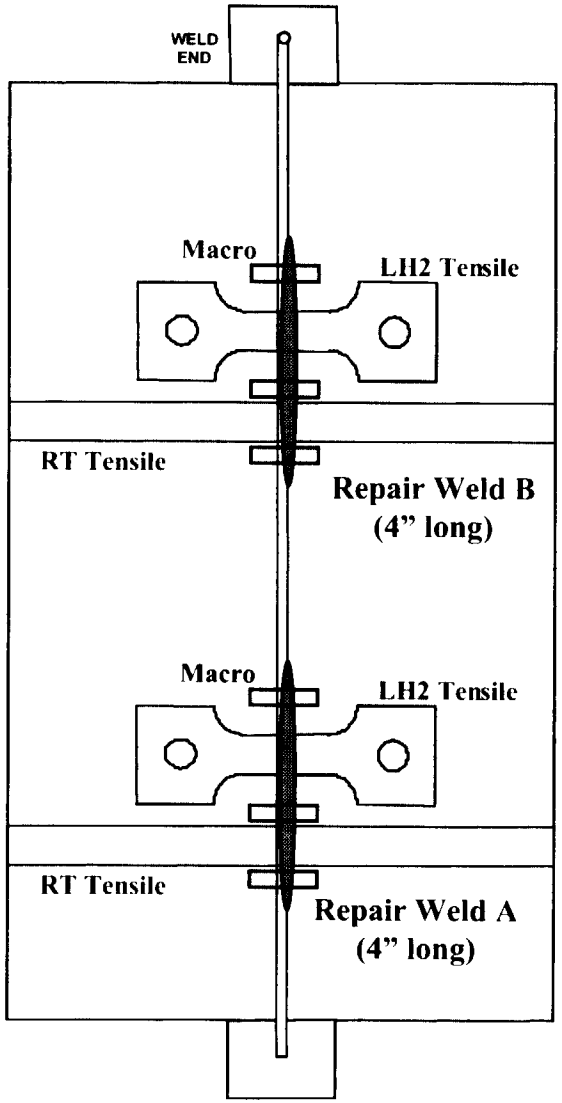
2195 Fusion Welding Improvements with New Filler Wire

VPPA/GTA Repair Weld Quick Look

- 14" X 24" Standard Repair Weld Panel

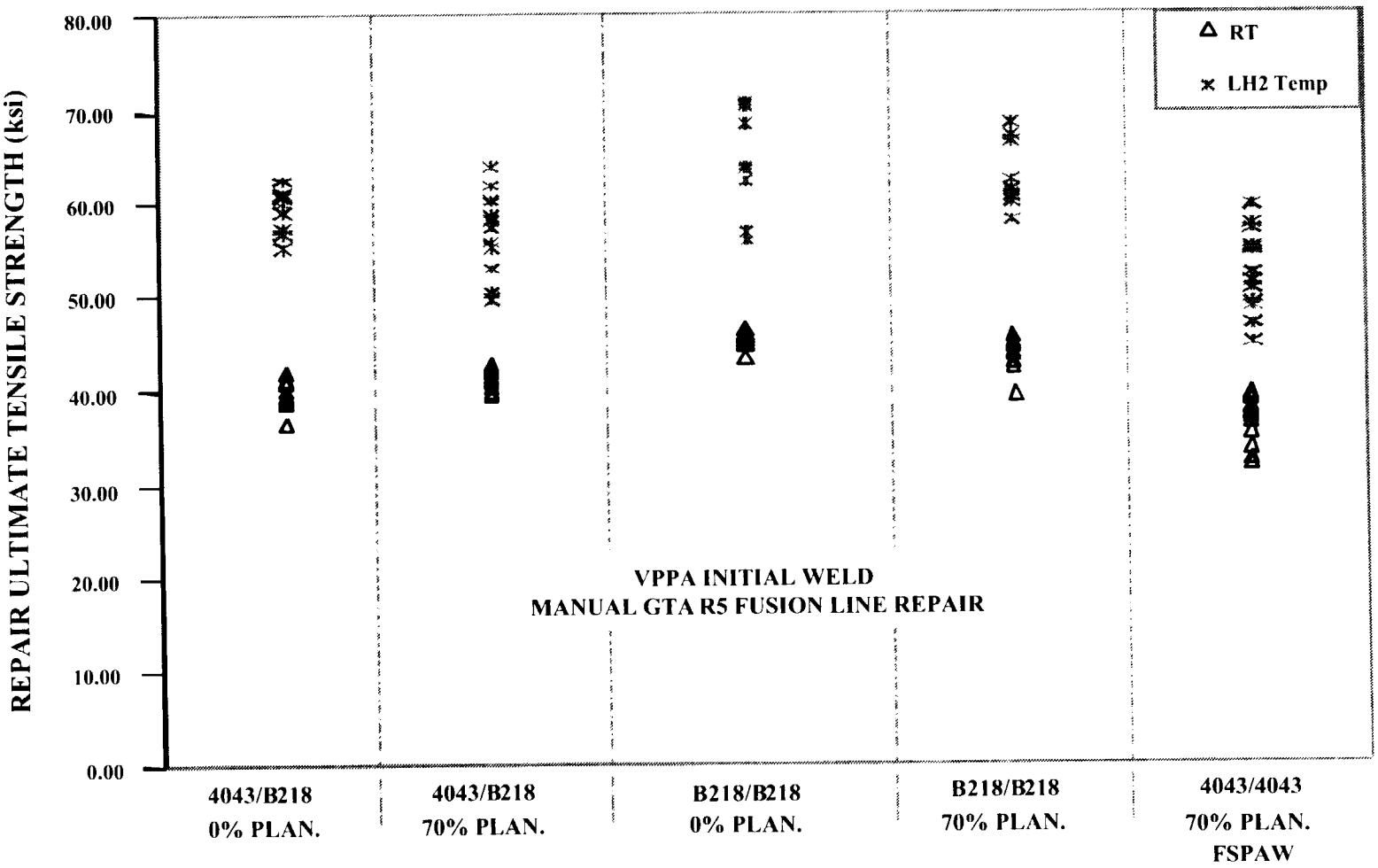


Manual GTA Repair Welding



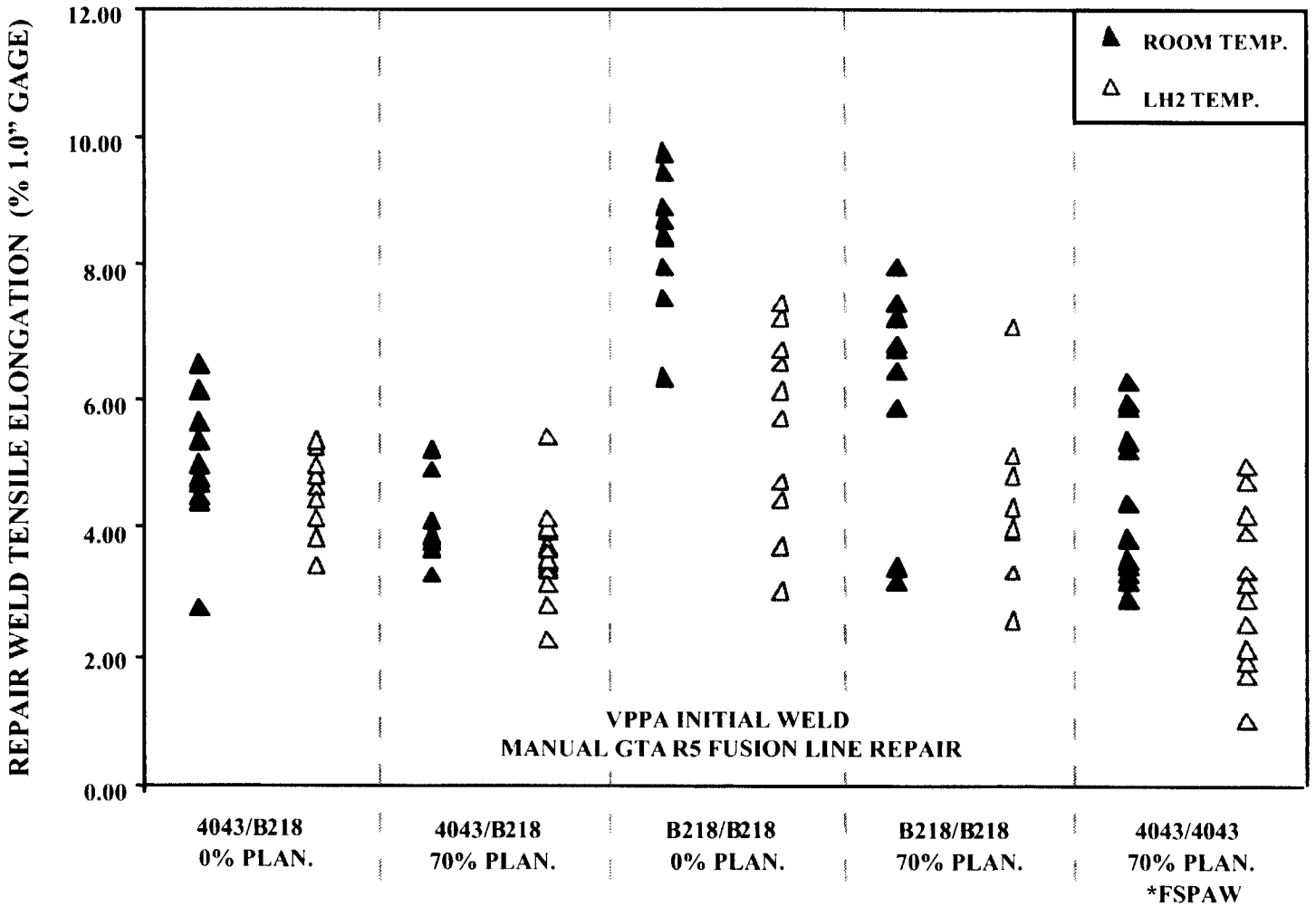
2195 Fusion Welding Improvements with New Filler Wire

0.200"t 2195T8M4 Repair Weld Ultimate Tensile Strength -Coupon Level



2195 Fusion Welding Improvements with New Filler Wire

0.200"t 2195T8M4 Repair Weld Ultimate Tensile Elongation - Coupon Level



2195 Fusion Welding Improvements with New Filler Wire

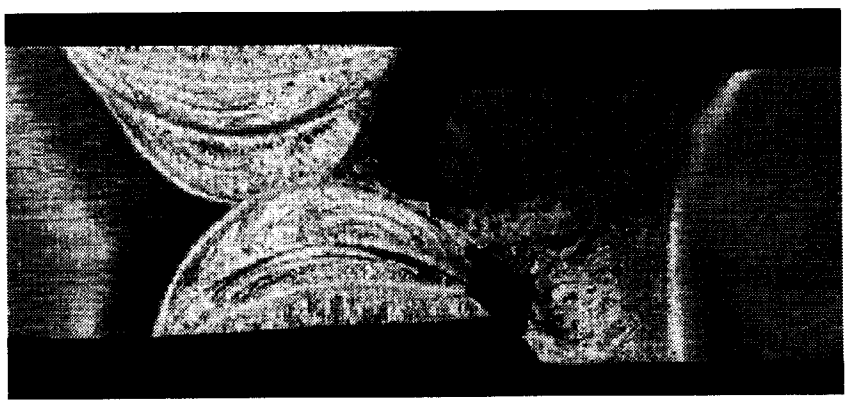
0.200t 2195T8M4 VPPA/ GTA Repair Weld Metallography

- **4043/B218 0% Planished**

7X Original Magnification

C008-RT02
RT Tensile Test
36.2 ksi / 2.74%El. 1" gage

C009-CT01
LH2 Temp. Tensile Test
62.5 ksi / 3.4%El. 1" gage

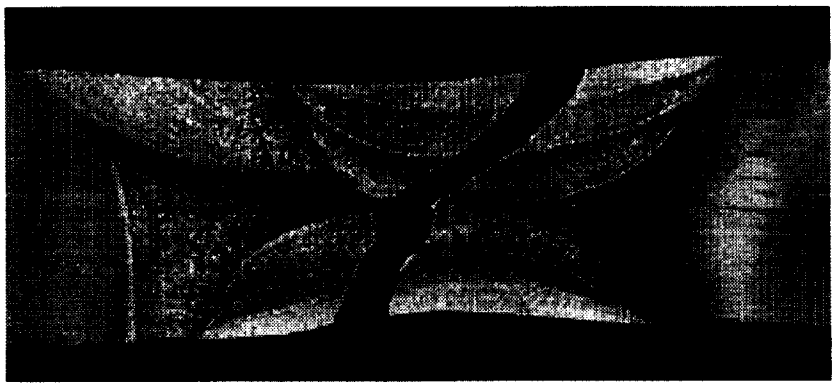


7X Original Magnification

2195 Fusion Welding Improvements with New Filler Wire

0.200t 2195T8M4 VPPA/ GTA Repair Weld Metallography

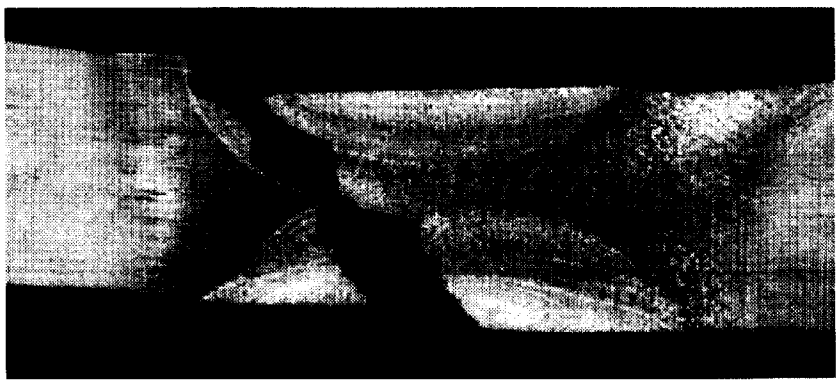
- **B218/B218 0% Planished**



7X Original Magnification

C080-RT01
RT Tensile Test
45.2 ksi / 9.75%El. 1" gage

C080-CT01
LH2 Temp. Tensile Test
68.1 ksi / 7.40%El. 1" gage

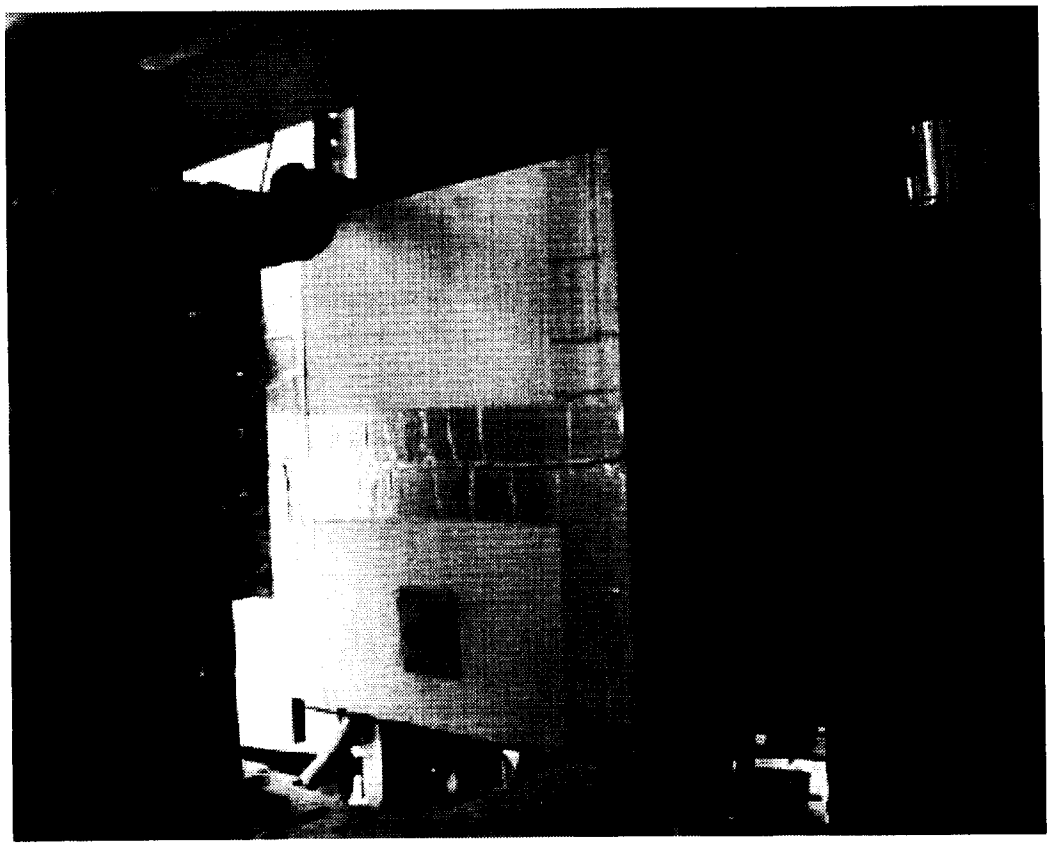


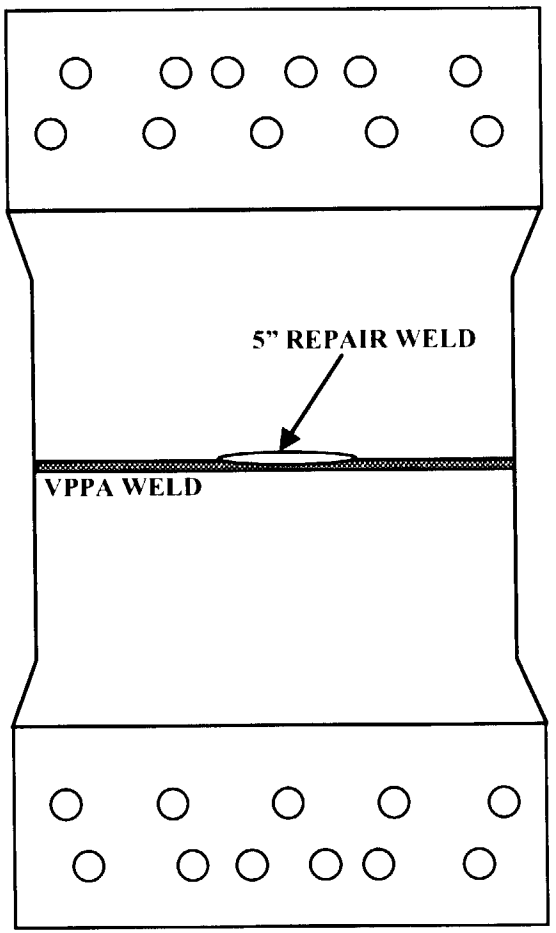
7X Original Magnification

2195 Fusion Welding Improvements with New Filler Wire

VPPA/ GTA Repair Weld Structural Simulation Panel Evaluation

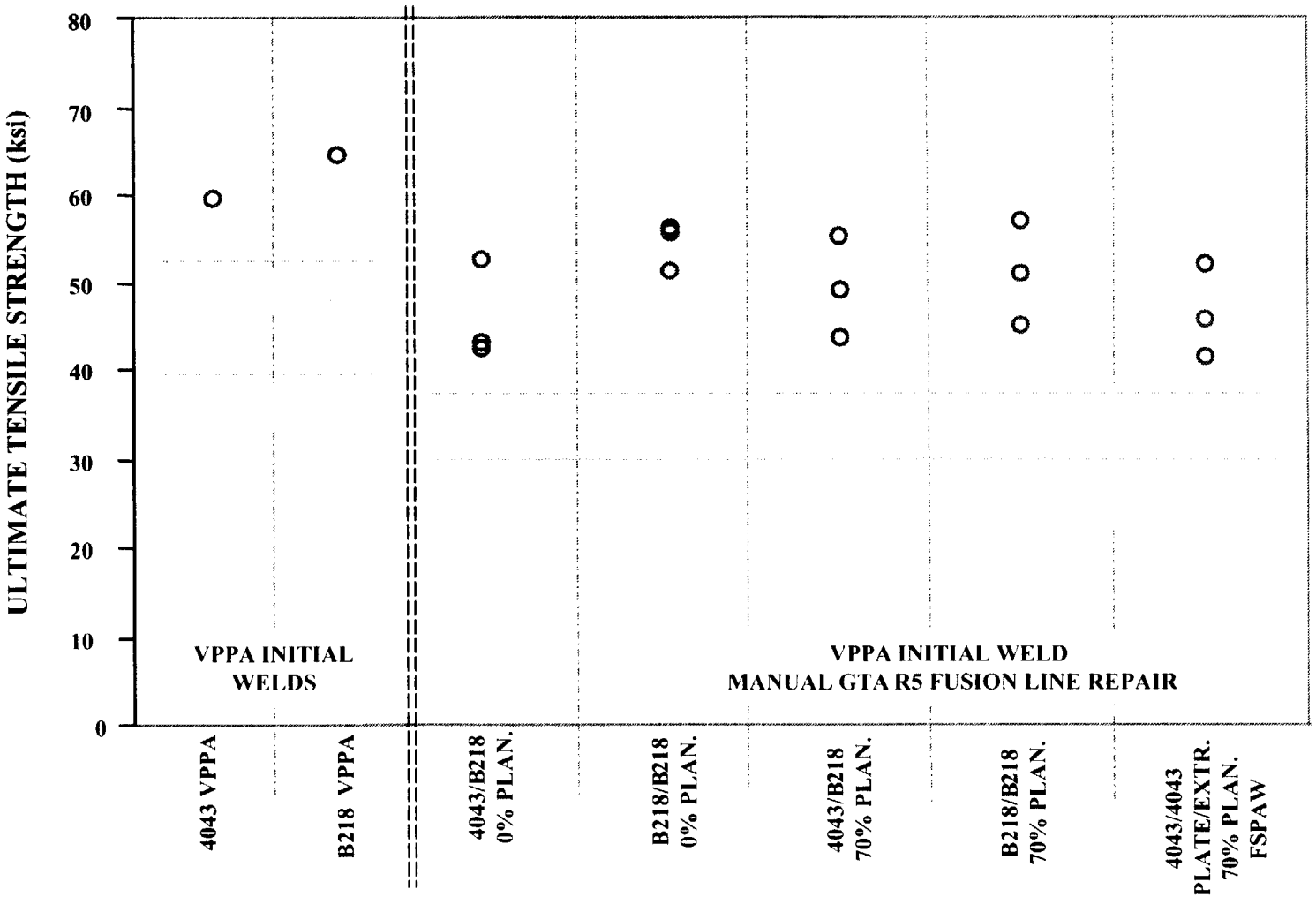
- 19" X 48" Repair Weld Wide Panel





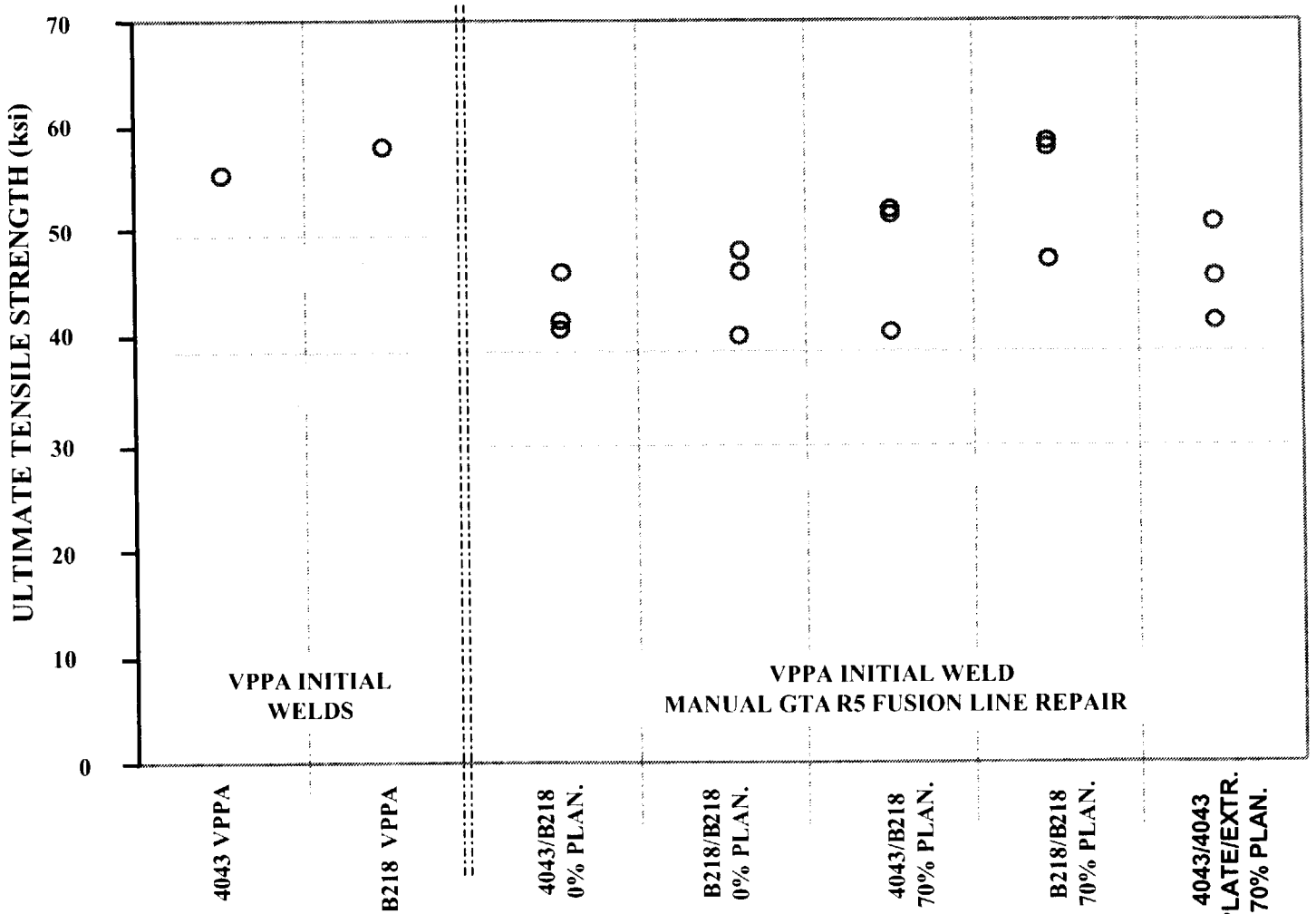
2195 Fusion Welding Improvements with New Filler Wire

0.200t 2195T8M4 Structural Simulation Panel Weld Tensile Strength (-423°F)



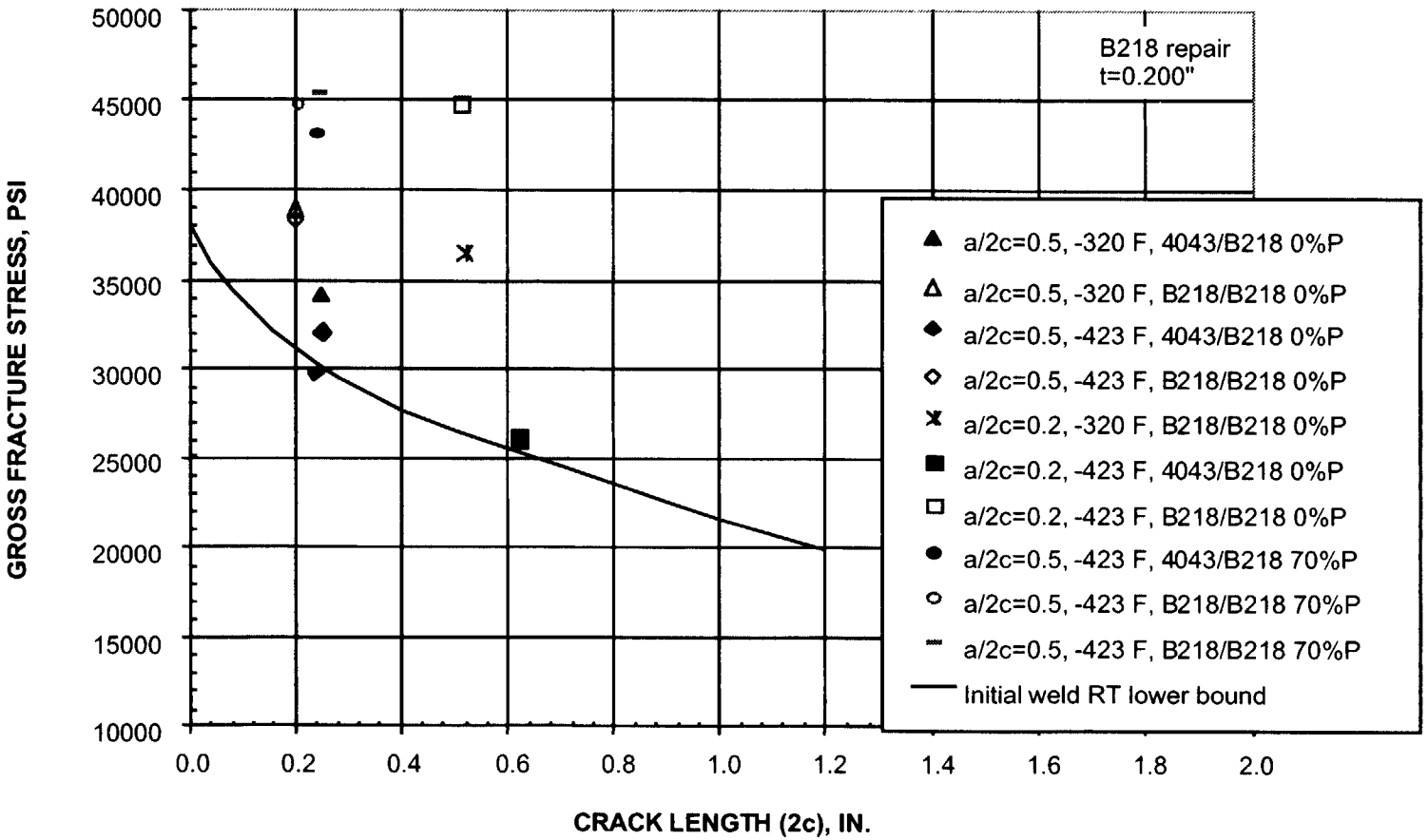
2195 Fusion Welding Improvements with New Filler Wire

0.320t 2195T8M4 Structural Simulation Panel Weld Tensile Strength (-423°F)



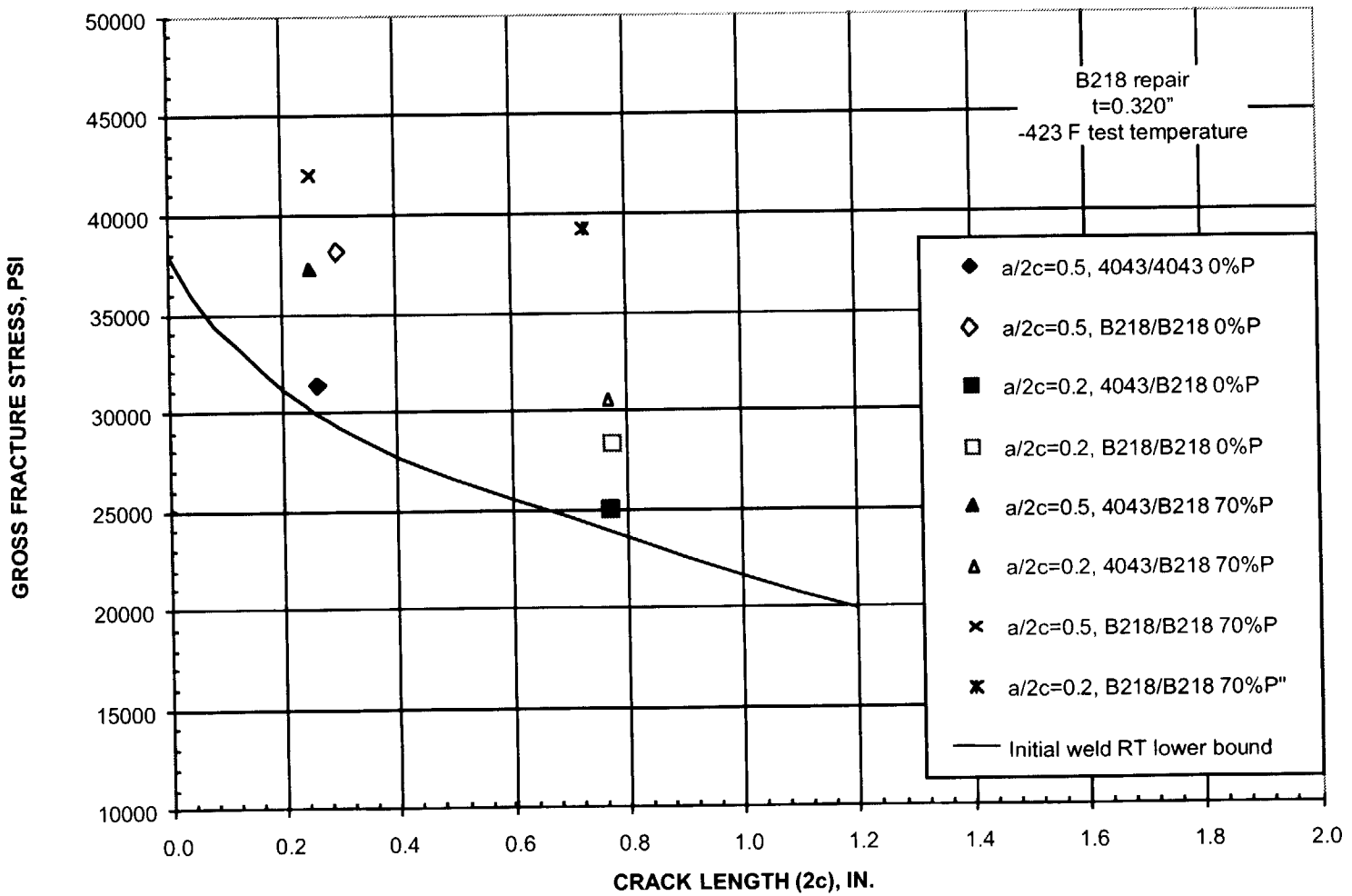
2195 Fusion Welding Improvements with New Filler Wire

0.200t 2195T8M4 VPPA/GTA Repair Weld Simulated Service Fracture Toughness



2195 Fusion Welding Improvements with New Filler Wire

0.320t 2195T8M4 VPPA/GTA Repair Weld Simulated Service Fracture Toughness



2195 Fusion Welding Improvements with New Filler Wire

Conclusions

- **B218 weld filler wire displayed higher repair weld tensile strength and ductility compared to 4043.**
- **Unplanished and planished B218 repair welds exceeded the current SLWT 4043 repair weld tensile strength requirement.**
- **B218 repair weld simulated service results surpassed 4043 repair welds and were comparable to 2195 initial welds made with 4043.**
- **B218 displays a high potential for improving SLWT production through increased repair weldability and the reduction/elimination of planishing for the removal of repair weld residual stresses.**